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NOTES ON
IMPROVED METHODS
OF
CANE CULTIVATION

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SUGARCANE RESEARCH
STATION, SHAHJAHANPUR.

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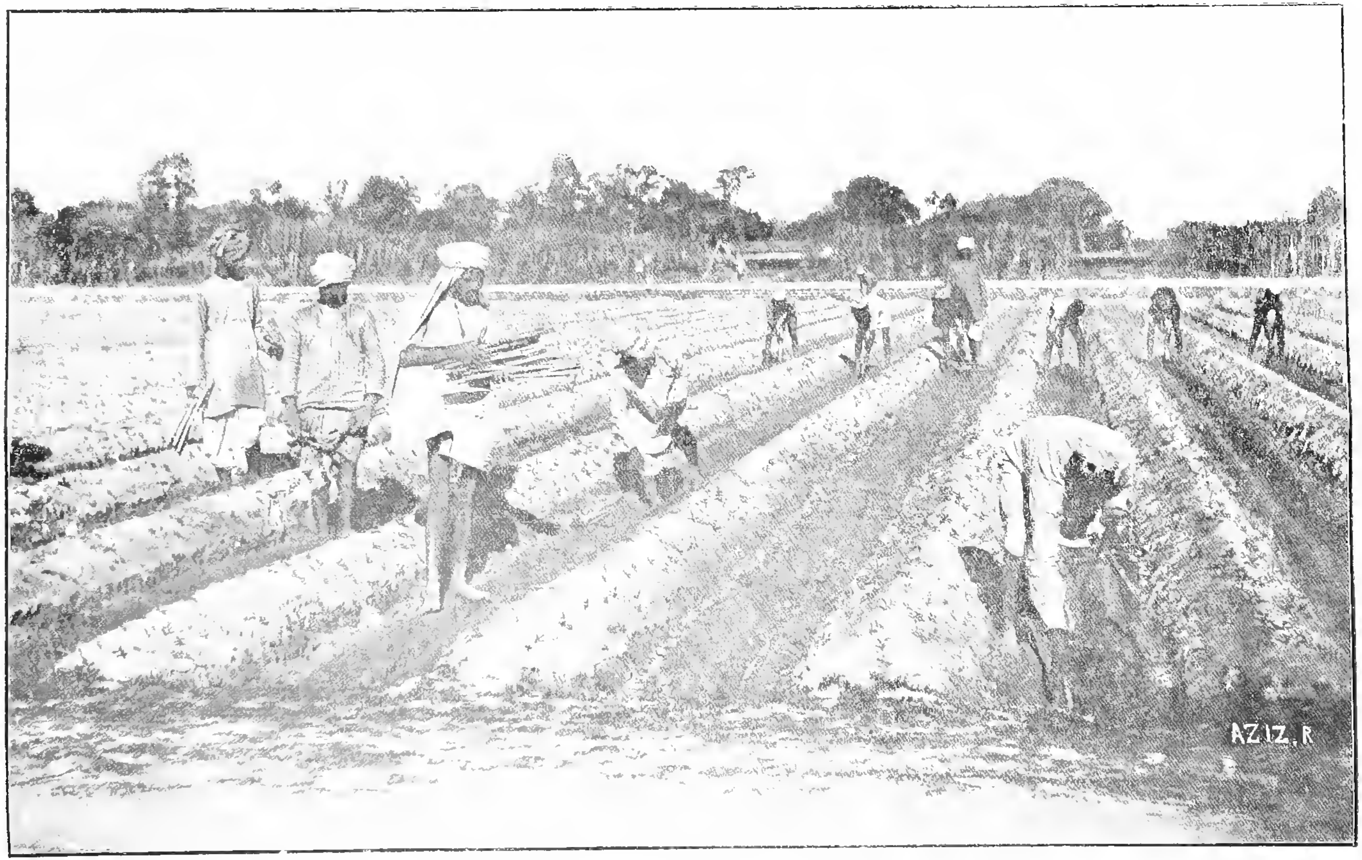

Fig 1. Planting Sugar Cane in trenches Shahjehanpur, March 1919.

Notes on improved methods of cane cultivation.

INTRODUCTION.

In the course of the experiments which have been carried out at the sugarcane research station, Shahjahanpur, on the selection of improved sugarcanes suitable for the United Provinces, it became evident at once that it would be necessary to work out better and more intensive methods of cultivation which could be used by zamindars and cultivators with a certain amount of capital at their disposal for cane growing.

The methods used by the cultivators, though quite suitable for obtaining a moderate crop of the favourite dhaul chunni mixture at a minimum cost, are quite unsuitable for obtaining the best results with improved varieties.

The first account of the results obtained at Shahjahanpur were published in a Bulletin 35 in 1916. Since then considerable progress has been made, and much additional experience has been gained. The first impression of the original bulletin has been exhausted, and it is proposed to take this opportunity of publishing the later results in a new bulletin with illustrations of the methods used, and the results obtained.

A large number of canes from most of the cane growing countries of the world have been under experiment.* These may be roughly divided into two groups :—

(1) Thick canes of the poundah type of which Ashy Mauritius and M16 are good examples.

(2) Medium canes of which the Natal and Java canes are typical.

To these must be added the new canes produced by Dr. Barber in Madras and known as Coimbatore seedlings. Twenty-two of these have been received up to date. Some are medium canes, and others are thin canes resembling the desi canes of Rohilkhand, from which many of them are derived by cross fertilisation with canes containing a higher percentage of sugar and juice.

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* Approximately 120 distinct varieties.

The experiments which are illustrated in this bulletin have shown that the cultivation by intensive methods of varieties of improved sugarcane, selected to suit the local conditions, is a profitable undertaking for the manufacture of rab and gur.

The conditions affecting the rainfall and climate of Upper India are such that seasons of deficient rainfall occur at intervals, and these conditions affect the quantity and the quality of the cane crop.

The period during which the cane is on the land is short (March to January) the period of vigorous and active growth remarkably so, being limited to the warm moist months of July, August, September and part of October, when the cold weather sets in, and growth ceases.

It will thus be seen that the climatic conditions make intensive cane growing more difficult in the northern parts of India than in tropical countries, such as Java and Cuda. The selection of canes suited to these conditions is also a matter of some difficulty. On the other hand this disadvantage is compensated for by the possession of a most excellent and suitable soil ; and as a result of this the United Provinces grows normally about half the cane crop of India.

The yield of cane and sugar per acre from crops of desi cane by the ordinary methods of cultivation is small. The official figures for the United Provinces for the year 1916-17 are given as 32·6 maunds of gur or 1·2 tons per acre.* In the periodical seasons of deficient rainfall, where unprotected by irrigation, the crop over large areas is liable to be a total failure.

The average yield, obtained at Shahjahanpur with nine selected varieties and improved methods of cultivation from

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* Report of Indian Industries Commission 1916—18. A pendix O.

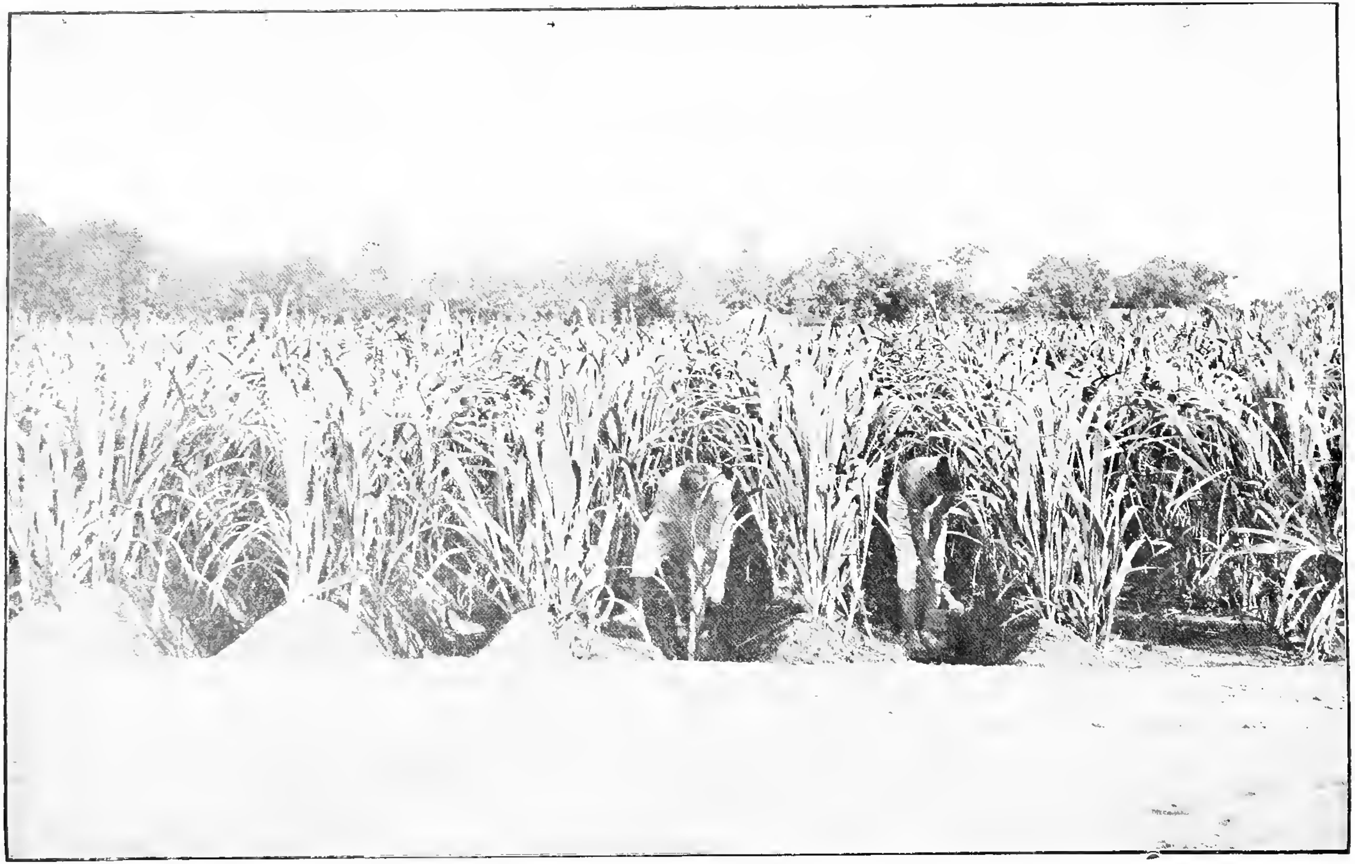

Fig 2. Earthing up Sugar Cane, July 10th 1919,—Shahjehanpur.

1914 to 1919, was 838 maunds of cane per acre (30·8 tons per acre). The average per cent. of sucrose in cane was 11·1. This gives a yield of cane sugar as per acre of 93 maunds or 3·4 tons which would give a yield of about 100 maunds of gur per acre.

These experiments have been continued for a period of five years over a yearly area of approximately ten acres, and may be taken as a guide to the possibilities of intensive cane cultivated on Rohilkhand soil.

The results recorded in the following table show the out-turn and quality of the cane of an imported variety (Ashy Mauritius) over a period of five years which includes one year (1918-1919) of deficient rainfall.

Season.	Rainfall (includes) February 1st to January 31st.	Yield of cane maunds per acre.	Yield of cane tons per acre.	Sucrose per 100 cane.	Sucrose per 100 juice.	Purity of juice.
1914-15	33·27	861	31·5	13·4	15·6	89·7
1915-16	62·02	780	28·6	13·6	16·2	89·0
1916-17	45·49	1,118	40·9	12·7	14·9	85·8
1917-18	64·86	938	34·7	13·4	16·2	87·2
*1918-19	25·96	604	22·1	11·1	13·4	82·5

The results give a good idea of what can be expected from this class of canes over a period of years, which has included the usual fluctuations of seasons and rainfall, with an efficient system of cultivation and the careful use of well irrigation.

The season 1918-19 as mentioned at the foot of the table was a year of deficient rainfall and scarcity. Very few bels were working in the Shahjahanpur district, and much of the cane in the cultivators' fields was unfit for crushing.

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* A season of deficient rainfall and scarcity. The crop in the Shahjahanpur district was almost a complete failure, and very few bels were working. The latter part of August, September and October were rainless.

The imported canes required naturally more irrigation, and owing to the dry atmospheric conditions prevailing at the times when the canes should have been growing most vigorously, the yield was the poorest on record (604 maunds per acre) for Ashy Mauritius. The yield of other imported varieties from Natal and Java was normal, viz., 1,054 and 969 maunds per acre, but the sugar was somewhat below the average.

It is interesting, however, to note that the prices ruling for gur and rab in the local bazars were so high, that the value of the produce per acre equalled, and in some cases exceeded, that of normal years. Gur was selling in the Shahjahanpur bazar at 3½ seers per rupee and rab at eight rupees per imperial maund.

As a result of the handsome profits that have been obtained in many places, there is a rapidly increasing demand throughout the cane growing tracts of the United Provinces for improved canes, and instruction and demonstration in intensive methods of cane cultivation.

The demand for seed at Shahjahanpur exceeds the supply every year, in spite of the fact that one of the earlier imported canes, which had been grown for some years in Southern India, did not maintain its vigour, and was attacked by one of the fungus diseases prevalent amongst a certain class of desi canes.

This unsatisfactory variety has now been replaced by new varieties, imported direct and raised from single sets at Shahjahanpur.

One of the chief causes that deter zamindars and cultivators from growing improved varieties of canes is the idea that these varieties require an excessive amount of irrigation. The amount of course varies with season, and the question is under investigation. It is known, however, as a result of experience at Shahjahanpur, that it is not so much as is generally supposed, if good preliminary cultivation is given; and suitable methods of moisture conservation, and soil aeration, are adopted.

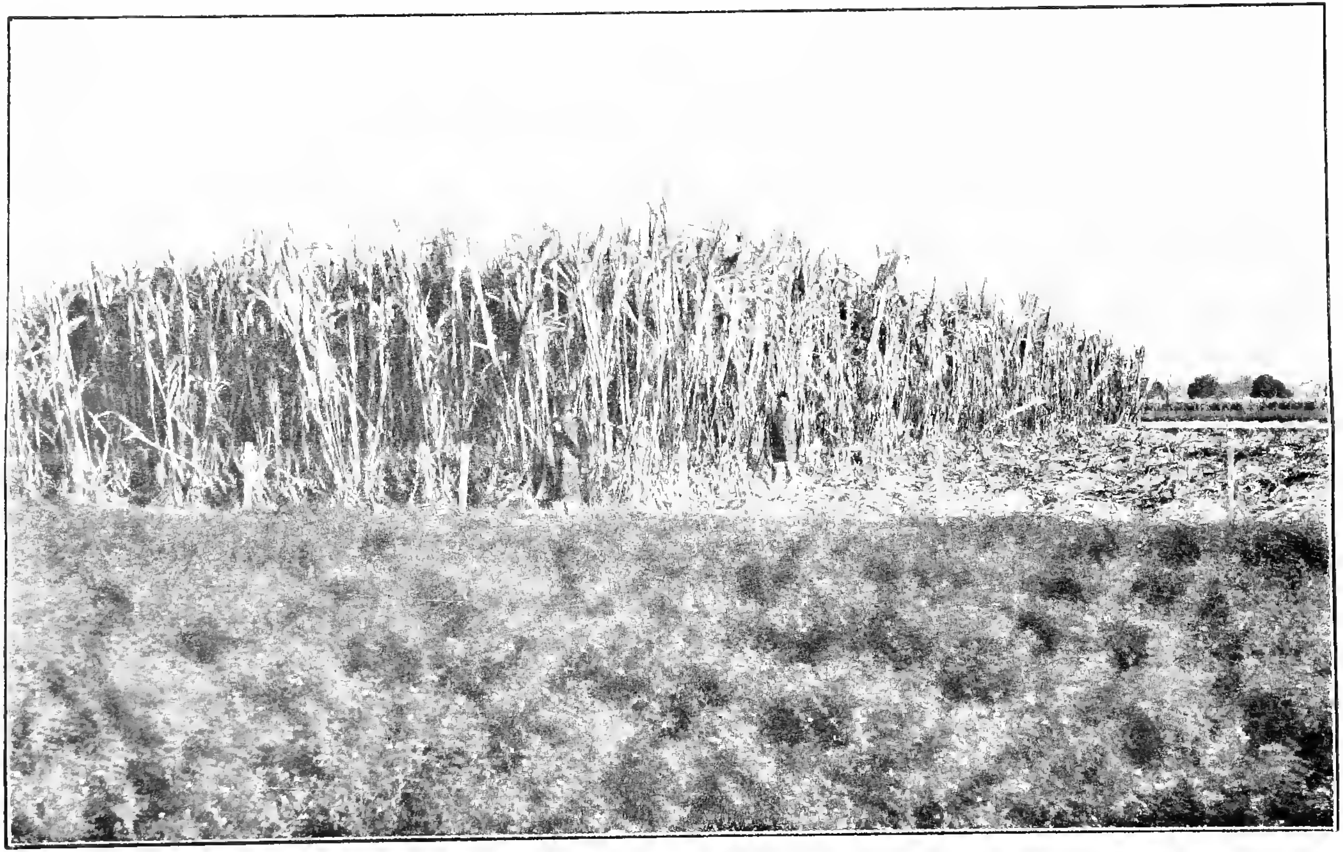


Fig 3. Field of Ashy Mauritius cane. Shahjehanpur, season 1917—1918. Yield, 948 maunds per acre. 13·4 per cent Sucrose in cane.

Many, in their earliest attempts to grow improved canes, do so on land that is permanently water logged from the time of sowing.

At Shahjahanpur with good winter rains on which the canes are sown, four waterings are generally sufficient to carry the crop on to the monsoon, if the land is thoroughly cultivated with kasis after each watering, to prevent the excessive loss of soil moisture.

It is generally recommended to those who wish to begin intensive cane cultivation that only a small area—one or two bighas—should be put down the first year, in order that the requisite experience can be gained without running any great risk, and a stock of seed obtained for larger operations the following year.

It has been frequently observed by those officers of the department, who have opportunities of observing the progress of intensive cane cultivation, that the earlier operations, such as preparing the trenches and sowing, are well done. A good germination is obtained, and the crop looks so flourishing and vigorous that the later cultivation which is so necessary for a good crop is neglected, or omitted altogether, particularly the most important operation of earthing up the canes. The result is the crop falls down during the storms of wind that are prevalent in the monsoon, and unripe juice and poor quality rab are obtained.

This sequence of events has been noticed so often, that it appears as if it was a necessary part of the education of the cultivator in improved cane cultivation.

It was thought at one time that it might be possible to use the intensive methods of cultivation described in this bulletin with the ordinary desi canes, but this has not proved to be the case. A certain amount of improvement of the desi crop is possible by better preparation of the land, but few desi canes will give the profitable results yielded by improved varieties with intensive methods of cultivation.

Heavy manuring with nitrogenous manure generally gives rise with desi varieties to excessive vegetative growth without a proportionate formation of sucrose or crystalline cane sugar, and moreover delays the ripening beyond the time when crushing operations are possible. A good example illustrating this statement was obtained at Shahjahanpur in 1916. Three plots were grown of Ashy Mauritius, J33 and Reora, one of the best indigenous canes of the Benares district.

These plots were generously manured, well cultivated and irrigated to see if it was possible to produce as large an outturn of sugar from Reora as from Ashy Mauritius and J33. The following results were obtained :—

Variety.	Yield of cane per acre.	Yield of sucrose per acre	Sucrose per 100 cane.
	Maunds.	Maunds.	
J33	723·2	84·4	11·67
Ashy Mauritius	779·8	105·9	13·58
Reora	785·9	55·2	7·03

It will be seen that it was possible to produce as large a yield of cane per acre from Reora as from the two improved varieties, but that the yield of sugar was 30 and 50 maunds less per acre, and the percentage of sugar in the cane was about half.

This result, and many similar ones that have been obtained, emphasise the fact that two things are necessary to bring the yield of sugar per acre in Upper India to the level of the great sugar manufacturing countries (1) improved methods of cultivation and (2) improved varieties. One is useless without the other.

Reference to figures 4 and 5 will show the crops of Pusa 12 wheat obtained in 1918-19 after growing the crop of Ashy

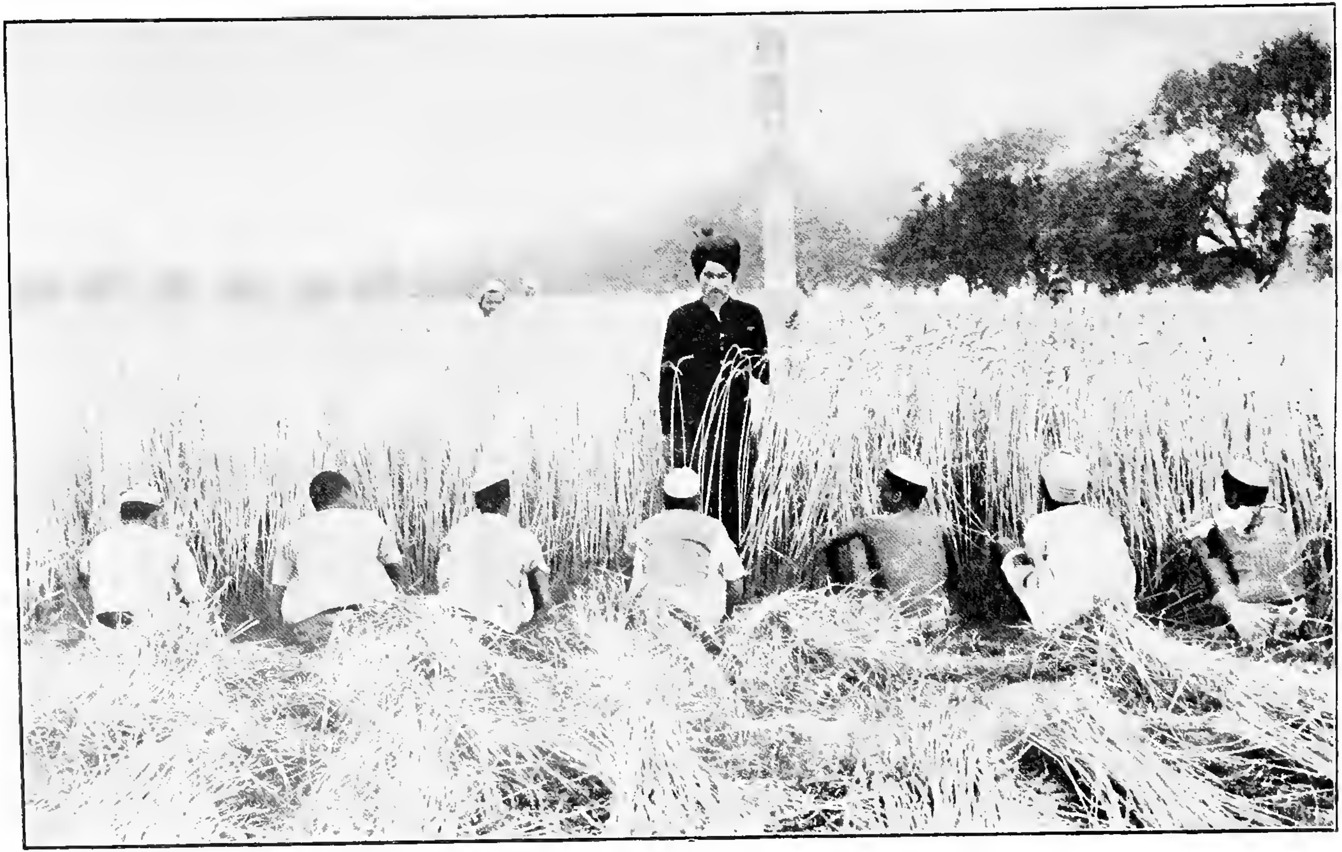


Fig. 4. Field of Pusa 12 wheat, season 1918—1919. Yield 36½ maunds per acre. Following crop of Sugar Cane shown in Fig. 3.

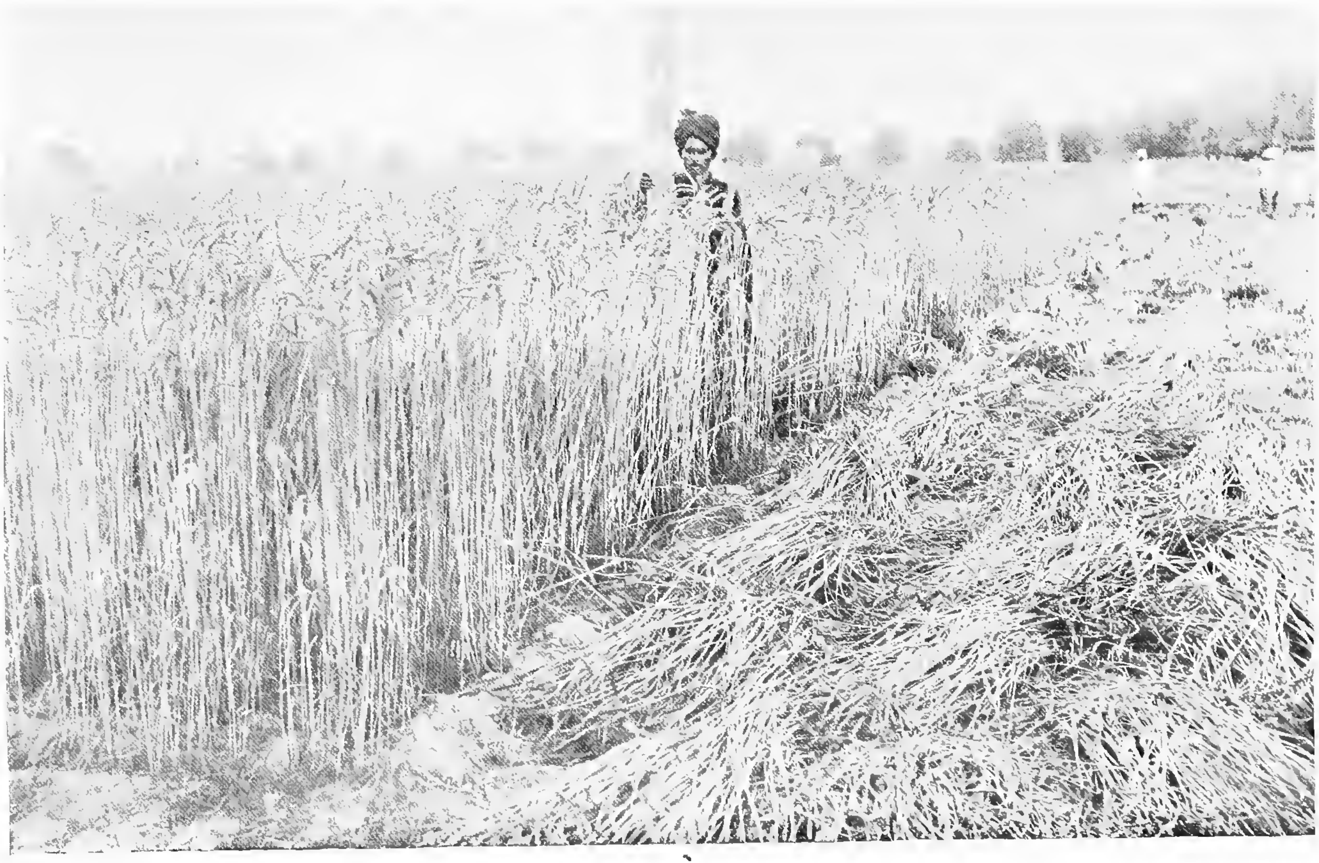


Fig 5. Another View of Pusa 12 wheat Shahjehanpur 1918—1919.

Mauritius cane illustrated in Fig. 3 in 1917-18. The yield from a field of 3½ acres was 36½ maunds per acre, and similar results have been obtained in the Western circle at Nawabganj, Bareilly. These results will be referred to later on, but it is not overstating the case to say that the additional yield of wheat covers the costs of the trenching and other operations involved in this method of cane cultivation.

METHOD OF TRENCH CULTIVATION.

The best and mort certain results with improved varieties of canes, both as regards germination and yield per acre, are obtained by sowing in shallow trenches as illustrated in Fig. 1.

The total cost of making the trenches and preparing them for sowing the cane is approximately Rs. 15 per acre at the Shahjahanpur Research Station.

The detailed expenditure is as follows : In a field 60 yards. wide, containing 60 trenches per acre, three men at a daily wage of annas 4 can make four trenches a day; the cost working out at Rs. 11-4-0 per acre. After the trenches are made they have to be dug at once to a depth of nine inches; one man can dig four trenches 60 yards long in a day. This works out at Rs. 3-12-0. The total cost being Rs. 15.

The cost at the Shahjahanpur Research Station probably represents a maximum. Where trenches are made under the personal supervision of the estate, or of the individual cultivator, this figure would doubtless be reduced. Last year at the Nawabganj Farm, Bareilly, much of the cultivation of the trenches, after they were made, was done by bullock power by means of a simple contrivance, devised by the Superintendent of that farm.

It should be remembered that so much depends on the thorough preparation of the trenches, and their preliminary cultivation before the cane is sown, that it is false economy to save a few rupees per acre by preparing the trenches indifferently. A crop of improved sugar will yield normally produce worth Rs. 400 to Rs. 450 per acre, and the amount spent on the preparation of the trenches cannot be considered an excessive outlay.

The method of trench cultivation is illustrated in Fig. 1. The actual illustration shows medium canes being sown in trenches 2 feet wide and 4 feet from centre to centre at Shahjahanpur on February 20th, 1919. The preliminary preparation of the land for sugarcane is based on the method commonly in use among the cultivators of Rohilkhand. There it is the universal custom to sow sugarcane on "*porach zamine*" or land that has remained fallow since the preceding rabi, and which has been cultivated during the rains and following autumn. As many as forty ploughings with the desi plough have been known to be given by the best cultivators.

It is no doubt due to the stimulation which this system gives to the recuperative agencies at work in the soil (Azotobacter and other organisms), that desi cane has been able to be grown for centuries without manure. Small yields, as has been pointed out, are the rule, but the yield does not appear to have undergone any diminution. It is about the same figure at the present time as that given in the Ain-i-Akbari.

The exhausting systems of rotation, that have grown up in canal districts, are not common except in very special areas in Rohilkhand.

The method of trench cultivation is as follows. After the removal of the rabi crop the land is ploughed with a turnwrest plough, if cheap irrigation is available. In Rohilkhand, where canal irrigation is not available, the natural moisture, after a season of normal winter rainfall, is usually sufficient, if the land is ploughed quickly after the removal of the rabi crop. In most seasons the occasional showers of from 0·5 to 1·0 inches, that occur in April and May, enable ploughing of the rabi land to be carried out before the hot weather sets in.

The land is left open during the hot weather. In the rains the land is ploughed with improved iron ploughs and desi ploughs as opportunity offers, and weather permits. It is not possible to say when this shall be done, but it is important that no opportunity should be missed. The amount of cultivation possible during the rains is probably one of the chief factors determining the following crop.

The trenches are made between the middle of October and the end of November. The most convenient time to commence this is immediately after the work connected with the rabi sowings is finished.

It is most important not to delay the making of the trenches beyond November. It must be remembered that the land is being opened up to a greater depth than with ordinary cultivation, and the newly exposed soil requires a certain amount of weathering, if a good tilth and seed bed is to be obtained.

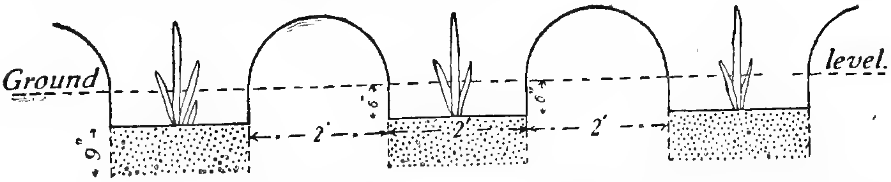
Unless trenches can be made at this time, it is not advisable to attempt this method of cultivation. It is no use starting to make trenches three weeks or a fortnight before sowing. This always leads to failure and disappointment.

For some years trenches of different sizes were used at Shahjahanpur, viz., 2 feet wide and 4 feet from centre to centre for the thickest canes such as Ashy Mauritius and M16; and trenches 18 inches wide and 3 feet from centre to centre for the medium canes such as the Java and Natal canes.

As a result of several years' experience it has now been decided that trenches 2 feet wide and 4 feet from centre to centre are most suitable for both thick and medium canes, if the land is in good condition and sufficiently manured. This size has been adopted at Shahjahanpur.

The sketch in the accompanying figure illustrates the arrangement. The trenches are 4 feet from centre to centre; each trench is 2 feet wide, and separated by a space of 2 feet from the next trench. The soil from each trench is removed to a depth of 6 inches, and placed on the two feet space left between each two trenches.

The whole making a series of ridges as illustrated in Fig. 1. The rows of canes are 4 feet apart.



As soon as the trenches are made they should be dug with kasis to a further depth of nine inches, and the dung, city refuse, oil-cake, or whatever manure is available, should be applied. The manure should be thoroughly mixed with the soil, and allowed to remain with occasional digging, if this can be arranged for.

It should be remembered that the more thorough the cultivation of the recently opened up soil at the bottom of the trenches the better will be the result.

To obtain a good crop of improved sugarcanes by this method of cultivation, manure containing 120 to 150 lbs. of nitrogen per acre is required. Local conditions will largely determine the cheapest form in which this can be obtained. In the United Provinces, where an extensive oil pressing industry is developing, the various forms of oil cake meal furnish an excellent source of nitrogen, which is very quickly available for plant food owing to the rapidity with which the bacterial action necessary to render it so, takes place in the soil of semi-tropical countries.

Castor cake meal is obtainable in moderate quantity in the United Provinces. It contains approximately 4½ per cent. of nitrogen, 5 maunds contain 18 lbs. of nitrogen, 35 maunds per acre will be equivalent to 126 lbs. of nitrogen per acre, 40 maunds per acre will be equivalent to 144 lbs. of nitrogen per acre.

The price varies from year to year and is usually between * Re. 1-8-0 to Re. 1-12-0 per maund f. o. r. Shahjahanpur. The

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* There has been a sudden rice in the price of caster cake since this was written the price in August, 1919, was Rs. 2-13-0 per maund.

outlay on manure is the heaviest cost the grower of improved sugarcane will have to meet. A handsome return is always obtained at Shahjahanpur for money expended on manure both from the crop of sugarcane, and the following crop of wheat.

The question of keeping down the cost of manure is an important one, and is under consideration; but it is not likely that it will be possible to reduce it to any great extent. The development of the oil pressing industry in India is one of the few things that would do so. Any steps that could be taken to extend the working up of oil seeds in the country would be an immeasurable boon to agriculture, and to cane growing especially.

Any kind of oil cake can be used, but it should be remembered that they do not all contain the same amount of nitrogen. Mahua cake meal, for instance, contains 2½ per cent. nitrogen. In working out the amount of meal to apply per acre the vitrogen content must be taken into consideration.

It was formerly the practice at the Research Station to apply the oil cake meal in two doses, one before sowing and one just before the canes were earthed up. There appears to be no advantage in this, and the whole of the manure is applied very soon after the trenches are made.

It may be pointed out again that the effect of liberally manuring the cane is not confined to that crop alone. The residual nitrogen, and the deep cultivation of the trenches, enables a bumper crop of wheat to be grown. Yields of 35 maunds per acre of Pusa 12 have been obtained for several years. In the harvest of the 1919 rabi crop 36½ maunds of Pusa 12 per acre were obtained over a field of 3½ acres with one irrigation of 4 inches in November. The preceding crop was Mauritius sugarcane, which yielded 948 maunds per acre (34·7 tons). These crops are illustrated in Figs. 3, 4 and 5.

Canes are sown in trenches from the end of February to the first week in March according to the season. It is useless sowing the canes before the soil is warm enough for the vigorous growth of the buds and young shoots.

At least a month before sowing the trenches are irrigated (4 to 5 inches of water), if the winter rains have not provided sufficient moisture. When the land is dry enough, the seed bed is prepared by digging the trenches with kasis ; and the cane is sown.

For this purpose, sound canes are selected, and cut into small pieces or sets, each set containing at least three healthy buds. The sets are planted in the bottom of the trenches in a small ridge 4 inches deep, and carefully covered up with earth.

The method of planting is shown in Fig. 1. Six men in the background are making the small ridges with kasis in the bottom of the trenches. Five men in the foreground are planting the sets in the small ridges at a distance of nine inches apart.

After planting, the trenches are carefully hoed and the canes left to germinate. About 6,000—8,000 sets are required per acre when the trenches are four feet from centre to centre. For thick canes, such as Ashy Mauritius and M16, 60 maunds of trimmed cane per acre are required ; and for medium canes 40 maunds.

After sowing and before the young shoots appear, the canes are hoed three times. This is not a difficult operation with kasis, the universal tool for cane cultivation in Rohilkhand. Care must be taken to see that the men work at the side of the trenches, and do not injure the young growing shoots, which have not yet appeared above the ground.

Hoeing with kasis is the common practice in Rohilkhand, and is an excellent one. It helps to keep the moisture in the soil, to aerate the latter, and to promote the proper decomposition of organic matter. It is infinitely superior to the superficial weeding that is often given with *kurpies.*

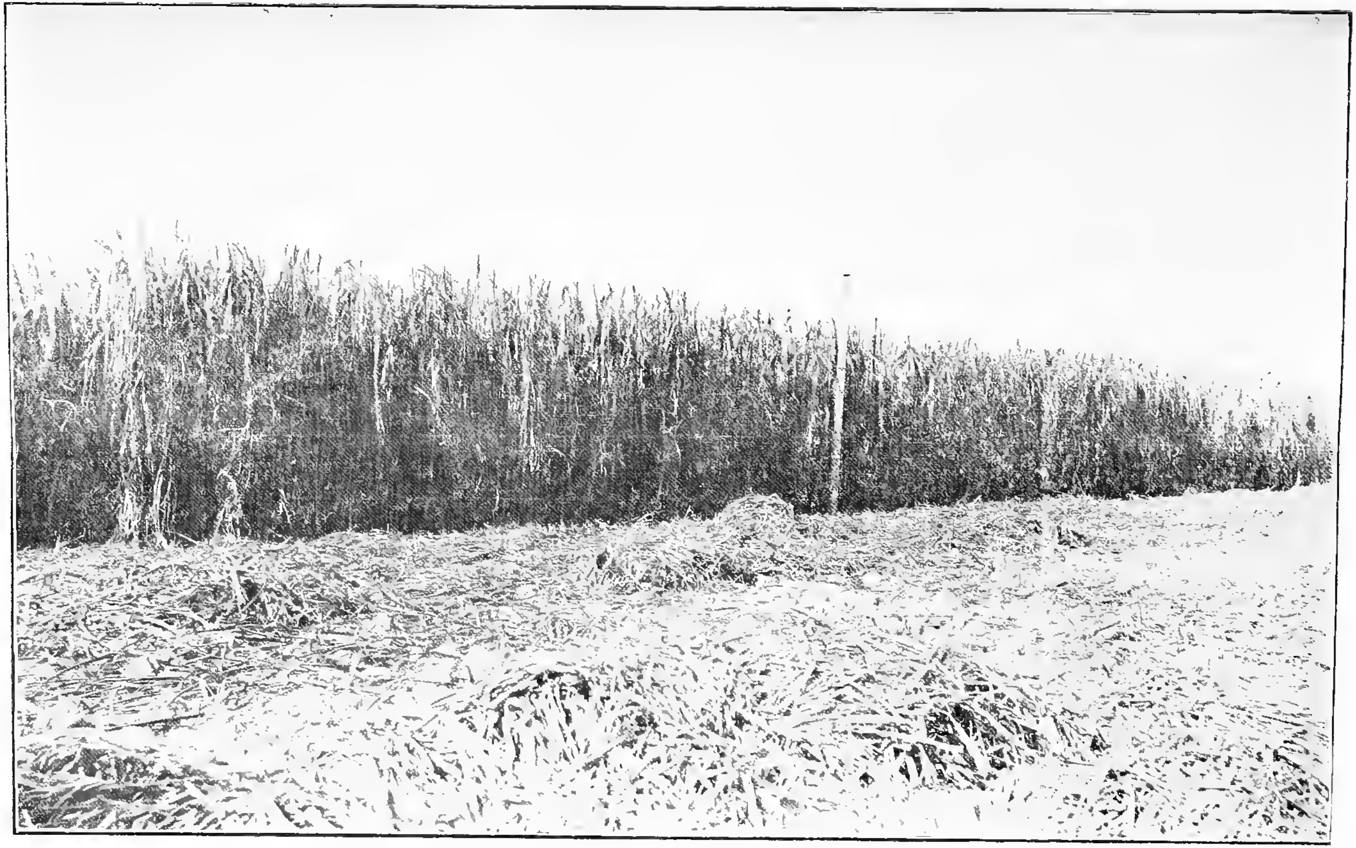


Fig. 6. Improved cane (S39) grown in trenches at Shahjehanpur 1918—1919, manured with castor cake meal.

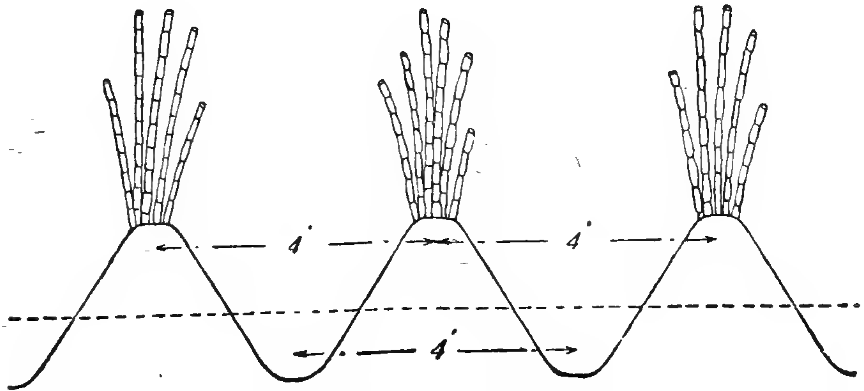
This is the time when white-ants give trouble, if it is a district where they are prevalent. Frequent cultivation helps to keep them within limits, but there is no cure for them, and as a last resort, if the attack is bad, irrigation must be resorted to.

In the normal course of event where white-ants are not particularly troublesome, a second irrigation will be required when the canes have germinated and are six inches above the ground about 5—6 weeks after sowing.

As soon as the young canes have begun to grow and tiller vigorously, when the young plants are about 2 feet high ; the trenches are gradually filled in. It is advisable to do this gradually, beginning about the middle of May, and completing the operation by the end of the month.

Before the rains begin the earthing up of the canes should be commenced. This operation serves to keep the canes standing during the monsoon, and the quality of the rab and gur depends entirely on the thoroughness with which this operation is carried out.

The importance of keeping the cane standing by earthing up cannot be over-estimated. Heavy crops of cane nearly always fall down during the monsoon, if this is not done. The quantity and particularly the quality of the rab and gur is badly affected. It is impossible to get the light-coloured danedar rab add gur so much prized in the bazars from a crop of fallen cane. When the earthing up is finished the field presents the appearance shown in the following diagram :—



During a normal monsoon, if the earthing up has been well done, very little attention is required, except that it is desirable to keep down the weeds by cultivating between the rows when weather permits. If the rains fail or are short this cultivation between the rows of canes is most essential.

If the monsoon is very poor an additional irrigation may be required in October, after which nothing more is needed until the harvest in the following January, February and March.

The method of trenching described above requires a certain amount of capital and irrigation facilities. It is suitable for those places in sugarcane districts, where wells, tube-wells, and pumping plant have been successfully installed. Indeed, at the present time a better method of getting a speedy return from the latter improvements cannot easily be found than the intensive cultivation of improved varieties of sugarcane for gur and rab manufacture.

The introduction of the cultivation of improved canes by intensive methods is an entirely different problem from the introduction of improved varieties of such crops, as wheat, gram and cotton, which show some beneficial result with little or no alteration in the existing methods of cultivation, and allow the potentialities of the new variety with regard to yield to be worked up to gradually by improved farming.

Such a course is not possible with new sugarcanes. The change must be immediate, from the poor yields of the indigenous varieties to nearly three times as much obtained by growing selected canes under intensive conditions.

It is not likely that a cane will be found giving the largely increased yield over desi varieties given by thick and medium selected canes, which can be distributed to cultivators, without instruction and demonstration in better methods of cultivation.

Progress in the case of improved cane cultivation will be slower and more difficult than the introduction of a new wheat, for example, which is soon measured in lakhs of acres.

The introduction of improved methods of cane cultivation will be accompanied by a general rise in the standard of agricultural practice throughout the provinces, and materially increase the yield of other crops. When the preliminary difficulties of initiating such a fundamental change have been overcome, improved methods of growing canes will be a most suitable and desirable method of demonstrating the advantages of better farming.

One thousand acres of improved canes would provide a central factory with between 7 and 8 lakhs of maunds of cane more than is now usually obtainable during a season. The extraction of crystalline cane sugar would increase from 7—7·5 to at least 8—8·5. One quarter of the above area, worked up with desi canes during the season, could not fail to exert a very beneficial influence on the extraction. 1·5 million acres cane are grown nominally in these provinces, one thousand acres is not a large proportion of that amount.

Figures 3, 6, 7, 8, 9 are illustration of crops of selected cane grown at Shahjahanpur. Figure 3 illustrates a crop of selected Ashy Mauritius cane grown in 1917-18. The yield was 948 maunds per acre (34·7 tons). The sucrose per 100 cane was 13·4. The sucrose per 100 juice 16·2, and the purity of juice 87·2. It was followed in 1918-19 by the crop of Pusa 12 wheat illustrated in Figs. 4 and 5 which yielded over an area of 3½ acres 36·5 maunds of grain per acre.

Figures 6 and 7 illustrate a crop of medium cane (S. 39) grown in 1918-19 (rainfall 25·9 inches). This cane was imported and raised at Shahjahanpur from a single set in 1912. The yield of the crop illustrated was 1,055 maunds per acre or 38·6 tons.

Figure 8 represents a crop of a medium cane (S. 50) also grown in 1918-19. The yield was 881 maunds per acre or 32·3 tons. The sucrose per 100 cane was 9·7 and the purity of the juice 80. Owing to the unfavourable weather in July, August and September the sucrose was below normal. This cane was imported, and raised at Shahjahanpur from a single set in 1913.

Figure 9 represents a crop of a medium cane (S. 48) grown in 1918-19. The yield was 969 maunds of trimmed cane per acre or 35·5 tons per acre. Sucrose per 100 cane 9·4, purity of juice 84. The sucrose owing to season was below normal. This cane was imported and raised from a single set in 1913.

METHOD OF INCREASING THE OUTTURN OF SUGAR IN THE UNITED PROVINCES.

To increase the sugar production of the United Provinces, it is more hopeful to look for an increased outturn per acre from the area at present under cane than for any large increase in the area sown. The former solution is preferable; the latter would lead to a further scattering of the fields under cane to greater distances. This is already a hindrance to the development of the centralised working up of the crop by both factories and small power mills.

To increase the outturn per unit area two lines of development are possible:—

(1) The extension of the intensive methods just described over *comparatively* small areas, that is areas small in comparison with the total area under cane in these provinces.

An area of one or two thousand acres is a small part of the 1·5 millions acre under cane in the United Provinces, but it would be a great advance, specially if the area was concentrated around central factories, or small power crushing mills.

This intensification would mean an immediate rise in the outturn of sugar per acre from 1·2 tons to 2½, if not 3 tons, per acre, as well as a striking increase in the yield of wheat and other crops. Capital, and intelligent supervision, are necessary to do this.

(2) The other method is to aim at a small increase over a very large area by gradual modification and improvement of the agricultural methods of the cultivator, such as deeper

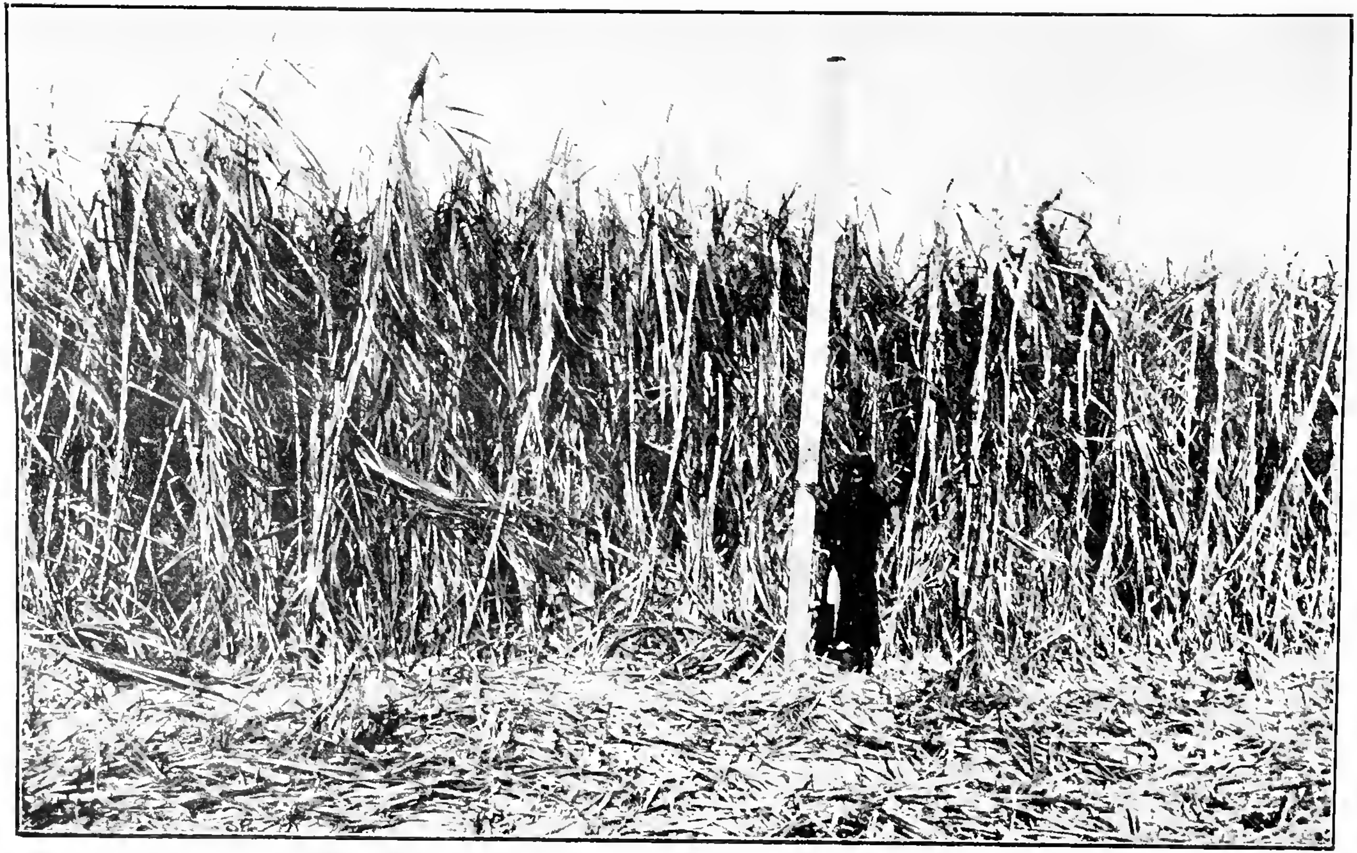


Fig. 8. Imported and selected cane (S50) Shahjehanpur 1918—1919.

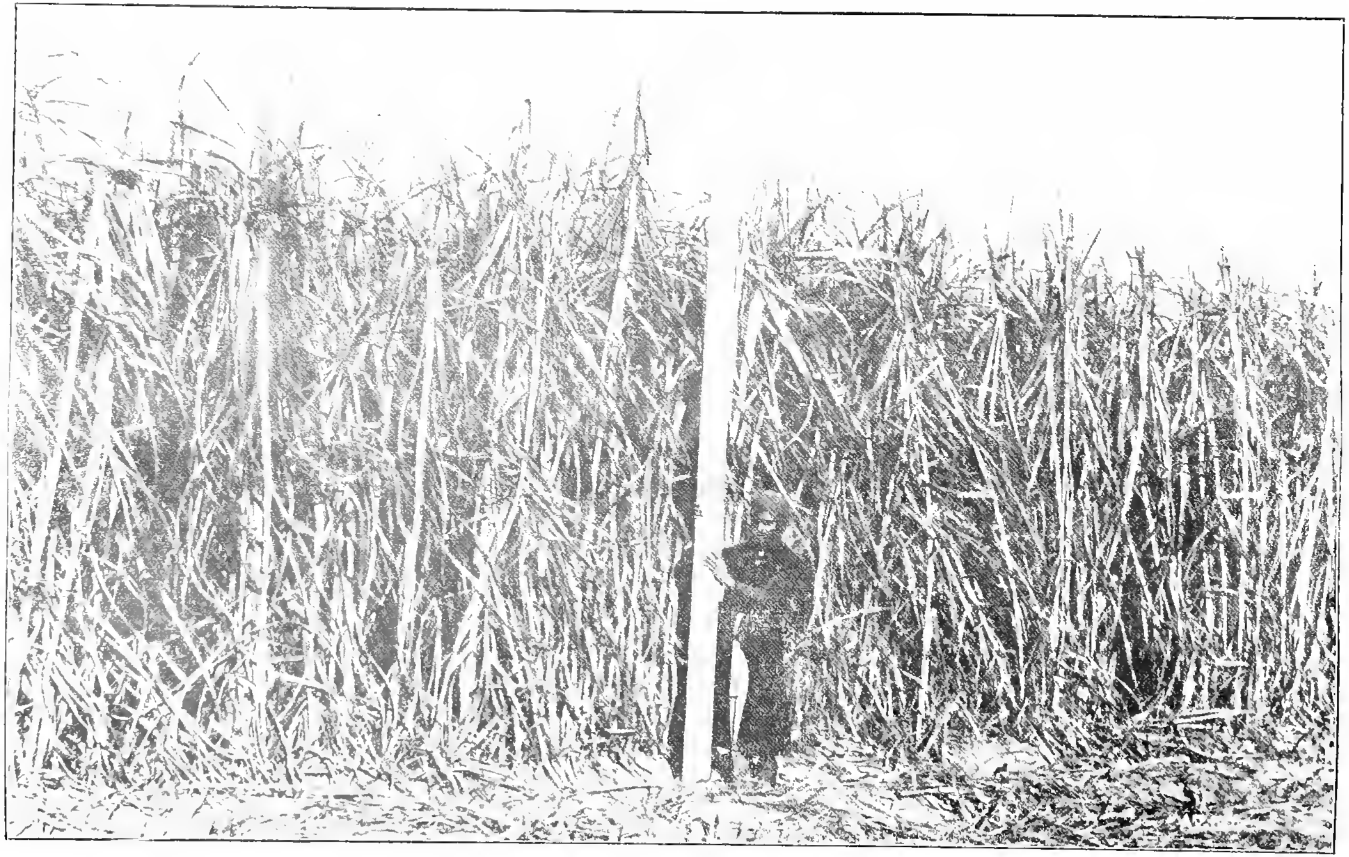


Fig. 9. Imported cane (S48) Shahjehanpur 1918—1919.

ploughing, the application of small quantities of manure, and growing pure races of the best desi and thin canes, instead of the mixture of good and bad at present sown.

The potentialities of the desi varties with regard to increased yield of sugar per acre vary considerable in different parts of the province, being apparently greater in the Eastern and North-Eastern districts bordering on Bihar than in Rohilkhand. It is useless, in most cases, to move desi varieties from one part of the province to another. As an example Reora, a most excellent indigenous cane of Benares, grows very indifferently at Shahjahanpur.

It was pointed out in the introduction that when big yields of desi canes are grown, by using intensive methods involving expenditure of capital, the returns of sugar and gur are not profitable. The potentialities of the best desi canes of Rohilkhand appear to be very limited. It is impossible to grow crops much above 400 maunds per acre without very adversely affecting the quality of the juice and gur or rab, and delaying the ripening beyond the time when the cane can be crushed.

As a rough estimate it should be possible by improved cultivation, not involving any pronounced departure from the common agricultural practice, to raise the outturn of gur 8—10 maunds per acre. It will be acknowledged that this would, if extended over any considerable area, add an appreciable amount to the supplies of the province.

It is an arguable point which of the two methods will lead to the speediest results. It is almost as difficult to get the cultivator to modify his methods as to change them entirely Both methods have certain points which recommend them under particular circumstances. There is little doubt however that central factories, whose profit depends largely on the percentage of sugar obtained from the cane, would do well to consider the question of growing improved varieties, which render the increased extraction possible without increasing the working expenses of the factory.

Both methods of improvement can be introduced simultaneously, and this will probably turn out to be the best solution.

This will resolve itself into the extension of intensive methods and improved varieties, where intelligent supervision, capital, and irrigation facilities are available; and the speeding up of the cultivators' methods by the introduction of better implements, and growing pure races of the best desi canes in tracts, where the cultivators are unable to carry out intensive methods.

IMPROVED CULTIVATION OF DESI CANES.

The following is a brief description of the methods followed at Shahjahanpur for the cultivation of the pure races of the desi canes of Rohilkhand that are grown there:—

After the removal of the rabi crop the land is prepared for sugarcane in the manner described in the preceding section. It is ploughed, and left open during the hot weather, and cultivated during the rains and following autumn. It is ploughed three times with a turnwrest plough and about 12 times with the desi plough. This is not a hard and fast rule and can be slightly varied as circumstances suggest.

Desi canes will not stand much manure, and our experience at Shahjahanpur is that the quality of the juice begins to deteriorate if more than 10 maunds per acre of castor cake is applied, to the varieties commonly grown in Rohilkhand. Any manure that is applied should be sown broadcast about six weeks before sowing, and thoroughly mixed with the soil by ploughing.

As there is no deep cultivation by digging as in the case of trenching, every effort should be made to secure a deep tilth by ploughing with turnwrest ploughs. In Rohilkhand the area under desi canes depends entirely on the winter rains; if these are good the sowings are large. If the winter rains fail desi cane must be sown on irrigation.

When the land is ready for sowing, after ploughing and levelling with the *patila* or wooden beam; straight lines are

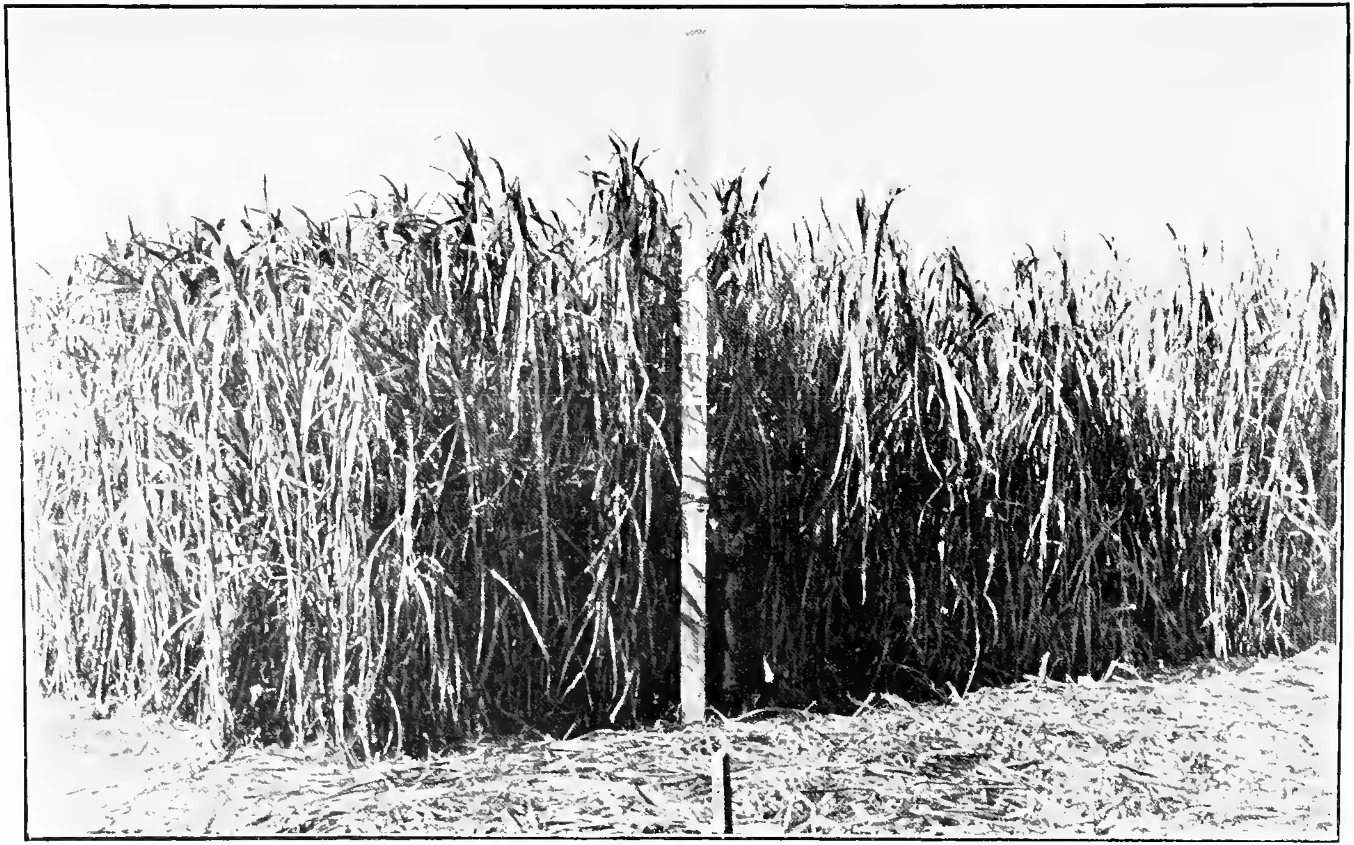


Fig. 7. Another View of the field of Cane shown in Fig. 6.

made in the field 24 inches apart. This simple operation is easily done by a man and two boys provided with a piece of string and two bamboo sticks cut 24 inches long. This has the great advantage of enabling the men at sowing time to plant the cane sets in straight lines. It costs practically nothing and greatly facilitates cultivation operations.

After sowing, the canes are frequently hoed with kasis. When the crop is established, the cultivation is the same as that given by the cultivators in the Rohilkhand. Irrigation is not always required, and not more than one irrigation is ever given at Shahjahanpur to desi canes.

The result of the better preparation of the land, and the small amount of manure, gives a small increase of cane and gur per acre, which if extended over a large area, would mean a considerable addition of gur. Nothing in the nature of the striking results, recorded in the previous sections, with selected canes and intensive methods, should be expected, and the following wheat crop is not much above normal. The following table gives results obtained at Shahjahanpur in 1918-19 with three pure races of canes selected from the indigenous mixture grown in Rohilkhand. As the land was in good condition no manure was applied.

No. of cane.	Yield of cane per acre.		Cane sugar per 100 cane.	Purity of juice.
	Maunds.	Tons.		
A 40 .	438	16·0	11·69	83·8
A 39 ...	474	17·3	12·47	87·5
A 42 ...	378	13·8	13·52	91·7

CULTIVATION OF MEDIUM CANES WITHOUT TRENCHING.

Some medium canes such as S39, S48, S50 have been grown without trenches at Shahjahanpur with some success on fallow land that has been well cultivated and manured with 20-25 maunds of castor cake meal.

The preparation of the land is the same as that described in the preceding section for the improved cultivation of desi canes. The manure should be applied soon after the rains and sown broadcast. The land should be ploughed with iron ploughs as deeply as possible.

At the time of sowing lines are made as described for desi canes, but in the case of medium canes these should be four feet apart.

The canes are sown with kasis in the ordinary way, and frequently hoed before and after germination, and after irrigation.

Before the rains the canes are earthed up in the same way as those grown in trenches and illustrated in Fig. 2. Thereafter the cultivation is the same as trenches.

The results are not so certain as when improved medium canes are grown in trenches, and the economical use of irrigation water is not so easy. The succeeding rabi crop is much inferior to that following cane in trenches. Quite good crops of cane have however been obtained by this method in good years, and unless the trenches are made in October or early November, and throughly well prepared, it is better to sow medium canes on the flat, than in trenches badly prepared one or two weeks before sowing time.

CANE CRUSHING BY MEANS OF SMALL POWER MILLS.

It has been pointed out previously in publications issued from the Chemical Section of this Department,* that the crushing of a crop of improved canes by bullock mills imposes a severe strain on the bullock power available coming, as it does just before the threshing of the rabi crop, which is also done by bullock power.

For some years a small power mill driven by a 7-9 HP oil engine has been in use at Shahjahanpur. This outfit is illustrated in Fig. 10, which shows M 16 cane being crushed in 1918.

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* Bulletin 42, Agricultural Research Institute, page 2.

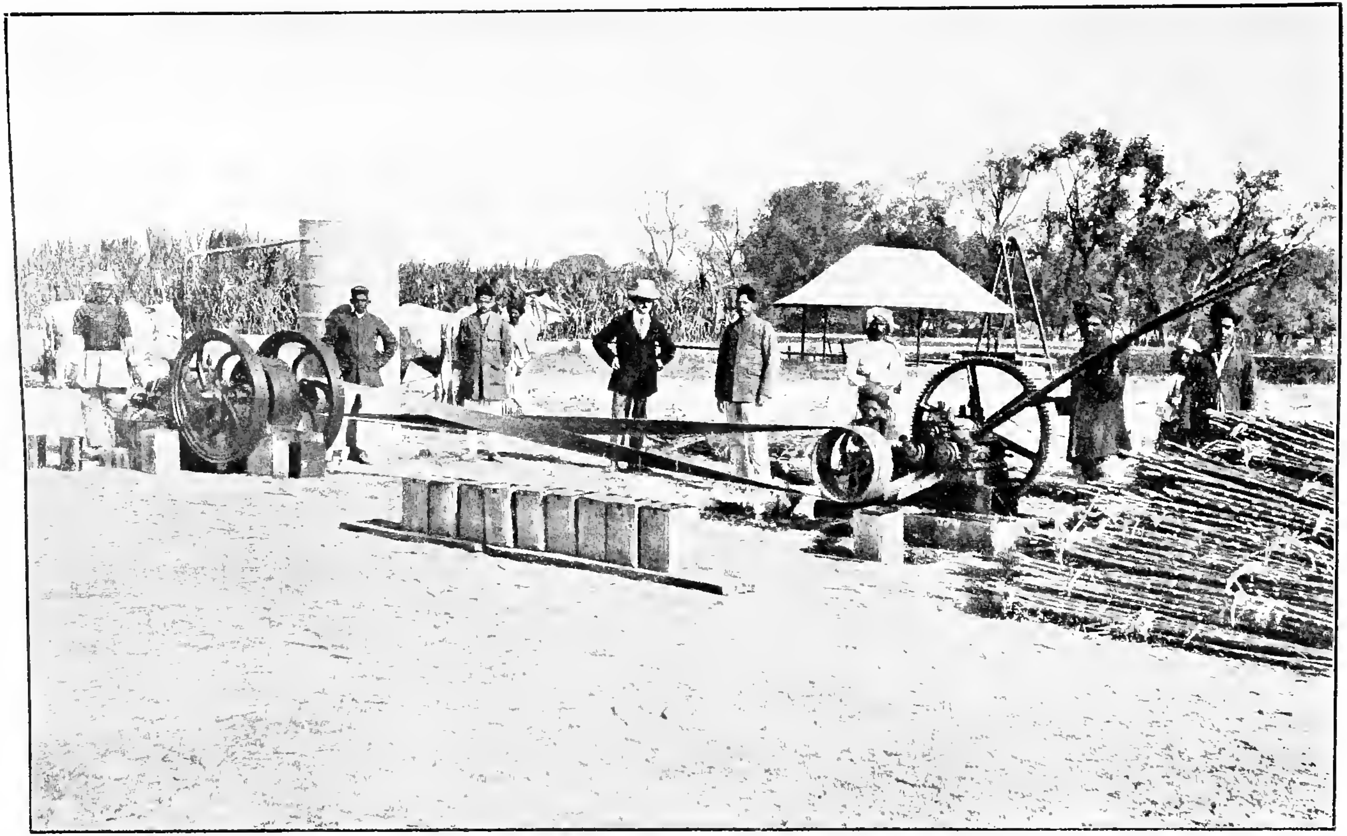

Fig. 10. Crushing Sugar Cane in Small Power Mill Shahjehanpur.

The mill in the illustration has been compared with bullock mills of various types both with reference to the amount of cane crushed per hour and the juice obtained.

The following table gives the results of a series of carefully carried out experiments :—

Cane used.	Type of mill used.	Maunds of cane crushed per hour.	Maunds of juice obtained per hour.
Desi cane ...	Three roller iron mill, bullock driven, rollers 8 inches.	2·53	1·69
Desi cane ...	Smaller type iron mill, bullock driven, rollers 6 inches.	1·83	1·09
Desi cane ...	Three roller power driven mill, illustrated in figure 10, rollers 8 inches.	11·6	6·52
Improved canes	Three roller power driven mill, illustrated in figure 10, rollers 8 inches.	14·6	9·31

Cane used.	Type of mill.	Juice obtained per 100 cane.	Extraction (cane sugar obtained in juice per 100 cane sugar in the cane).
Desi ...	Three roller iron mill, bullock driven, rollers 8 inches.	66·8	80·6
Desi ...	Smaller type iron mill, bullock driven, rollers 6 inches.	59·7	74·7
Desi ...	Three roller power driven mill, illustrated in figure 10, rollers 8 inches.	56·2	69·6
Improved canes	Three roller power driven mill, illustrated in figure 10, rollers 8 inches.	63·8	77·8

From these figures it will be seen that in a working day of eight hours 6 larger size bullock driven mills requiring 24 strong bullocks, and 8 smaller type bullock driven mills requiring 32 bullocks crush approximately the same amount of cane as the power mill illustrated in figure 10. The amount of juice yielded under these conditions is sufficient to keep a five pan Rohilkhand bel working.

An average crop of 10 acres of improved canes will take six large size bullock mills with 24 strong bullocks working in relays 60 working days of eight hours to crush. The same area can be crushed with one small three roller power driven mill, such as that used at Shahjahanpur, in the same time.

In the neighbourhood of central factories, where the cane can be sent to the factory the difficulties connected with the crushing of crops of improved cane do not occur. In other places the introduction of some kind of power crushing is imperative before any area of 10 acres and over is put down.

The large and efficient mills of central factories extract over 70 parts of juice per 100 of improved canes, as compared with 63—64 parts per 100 cane obtained by the small power mill at Shahjahanpur.

It will thus be seen that there is room for considerable improvement in the latter type of mill. Experiments were contemplated, but were stopped by war conditions. It should not be a difficult mechanical problem to improve the extraction of small power mills by the introduction of an additional set of rollers.

This is one of the most urgent needs of the province for the development of sugarcane growing ; as already pointed out it will probably precede the introduction of central factories.

ROTATION OF CROPS AT THE RESEARCH STATION, SHAHJAHANPUR.

It may be of interest to mention the rotation of crops which has been followed at the Shahjahanpur Research Station since it was started in 1912.

Sugarcane is grown every fourth year. After the removal of the cane crop, the ridges are levelled, the land ploughed, and left open during the hot season.

A crop of Pusa 12 wheat is sown in the autumn. Reference to Figs. 3, 4 and 5 will show the crop of sugarcane obtained in 1917-18 and wheat in 1918-19 from the same field of 3½ acres. The yields, as already stated, were 948 maunds of cane and 36½ maunds of wheat.

After wheat the land is left fallow during the summer, and a crop of gram sown during the following rabi season. The land is then prepared for another crop of sugarcane.

The rotation is thus :—

Sugarcane.
Summer fallow.
Wheat.
Summer fallow.
Gram.
Summer fallow.
Sugarcane.

The results obtained at Shahjahanpur amply justify the expenditure on manure and cultivation for the cane crop.

It has been suggested to the authors by Mr. A. Howard, Imperial Economic Botanist, that a crop of cattle food should be sown as a kharif crop between the wheat and gram ; thus making use of any available nitrogen before a leguminous crop is grown.

There will thus be two kharif crops during the four year rotation.

This valuable suggestion will be tried at Shahjahanpur.

The rotation will then be :—

Sugarcane.
Summer fallow.
Wheat.
Kharif crop.
Gram.
Summer fallow.
Sugarcane.